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## THE CEMENT GUN IN WATER WORKS PRACTICE<sup>1</sup>

BY L. R. TALBOT<sup>2</sup>

In the past eight or ten years the cement gun has become closely identified with the water works business. During that period a large number of reservoirs have been built or repaired by the use of the cement gun. There is hardly a state in the country which has not within it an example of the successful application of this method. The territory represented by the members of this Section can offer a large number of such illustrations, while Muscatine, Iowa, holds the distinction of being the first city to have had a reservoir lined in this manner.

For this reason, it is a pleasure to describe to you briefly the elements of this process and to point out a few of the many instances of its application.

"Guniting" is the cement and sand product of the cement gun. This material has been successful in this kind of work because, when properly placed, it makes a water-tight job, which will not crack or check when properly reinforced. As it is placed with an air pressure of from 30 to 40 pounds per square inch, it is driven into the surface and forms a coating that is 40 per cent more dense than hand or machine mixed mortar. In other words, the same amount of dry material when deposited by the gun would require only 60 per cent as much volume as the same amount placed by hand. Because of this density, its strength is over twice that of ordinary concrete.

The material may be placed at a considerable distance from the gun, thus obviating the necessity of an extensive handling plant. A thin coating may be applied without the use of forms or other preparatory work, except cleaning the surface and applying the reinforcing, both of which must be done in any case.

The gun is adaptable for building new reservoirs which are above ground, as well as lining the excavated type. Seven years ago, a

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reservoir was built at Elmhurst, New York, without the use of forms of any kind. The reinforcing was erected and a light frame used as a backing until enough material had been deposited to support itself, when the frame was moved ahead. A better scheme than this was used at Ford-City, Pennsylvania, last year, where a circular reservoir 110 feet in diameter and 17 feet deep was constructed of "Gunite." The only poured work was that for an annular footing slab under the wall. Vertical reinforcing consisted of one inch square rods and horizontal reinforcing was one inch twisted bars, spaced according to pressure requirements. Two layers of mesh reinforcements were used. The reinforcing was erected entirely and tied together, then a light wood form or backing was built on the outside and against the steel. Mesh was applied to the inside and the inside was "shot." The forms were then removed and another layer of mesh applied to the outside and the outside was shot, bringing the wall to the required thickness. The walls were 13 inches thick at the bottom and tapered to 5 inches at the top. The floor was about 4 inches thick and reinforced with mesh in both directions. It has been in use about a year now and is giving perfect satisfaction. The contract price was \$45,000 complete, which was less than bids that were received by the city for a poured concrete tank of the same dimensions. Labor and material prices when the job was built were about at their peak, so that a similar tank could probably be built at the present time for much less money.

At Kansas City, the Turkey Creek reservoir was lined last year and put in good shape and beyond the need of repairs for a long time to come. At the present time they are finishing up a portion of the Quindaro reservoir at the same place.

Trouble in maintaining linings, at Council Bluffs due to ice conditions and general deterioration, was experienced. The walls were cleaned off and a coating of reinforced "Gunite" was applied to solve the difficulty. In addition, the new reservoir is having a light coat applied over the surface for water proofing purposes.

The reservoir at Mt. Vernon, Iowa, showed ground water seepage. The reservoir is underground, the bottom being 26 feet below the surface. The seepage amounted to about 100,000 gallons in twenty-four hours when the reservoir was kept pumped down. When it was decided to remedy this condition, the reservoir was pumped down and about 20 weep pipes were put in to take care of the inflow, thus drying the walls. "Gunite" was applied in successive coats,

until 5 inches had been placed over the area where the seepage was worst. Finally the pipes were capped and were covered with a knob of "Gunite." No trouble has since been experienced.

One of the largest jobs done this year, amounting to about 250,000 square feet, was the lining of the walls of the reservoir at Nashville, Tennessee. Some work was done at Nashville in 1914 which was successful. The present job consists of coating the entire surface walls with "Gunite," then placing a coating of mastic, and finally a 3-inch coat of "Gunite."

At Pittsburg, Pennsylvania, a few years ago, the Herron Hill reservoir, which is of 10,000,000 gallons capacity and the oldest in the city, was leaking at the rate of 1,000,000 gallons a day or 10 per cent. It was cleaned out, and a 2 inch "Gunite" lining was applied, reinforced in both directions with American Steel and Wire triangular mesh. It was estimated that a saving of \$70,000 was effected on this job by using "Gunite" rather than a poured double slab, which was what they had originally intended to use. The lining was made continuous with no expansion joints. A solid panel fence was built around the reservoir and a watch house was built with the cement-gun. A test made after the completion of the work showed a loss of less than 10,000 gallons in twenty-four hours, with no correction for evaporation.

Much the same methods were used in lining the Lake Elizabeth reservoir on the North side of Pittsburgh, and this fall it was decided to line the Highland reservoir No. 2. This is a 100,000,000 gallon reservoir and totals 750,000 square feet, of which about 75,000 square feet are being surfaced this fall and the remainder is to be done next season.

In addition to the projects enumerated above, brief mention should be made of similar work carried out at Montreal, Quebec, on the Outremont Reservoir, at San Francisco, California, on the Twin Peaks Reservoir, at Elmira, New York, and at Great Falls, Montana for the Anaconda Copper Company.